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A METHOD OF SITE EVALUATION FOR YELLOW POPLAR BASED ON DEPTH OF THE UNDISTURBED A_1 SOIL HORIZON

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A recent study of yellow poplar growth as related to site conditions in the Central States (Station Note No. 32) has indicated that depth of penetration of organic matter in the surface soil may be a good index to site quality. Accordingly this progress report has been prepared as an aid to foresters in recognizing areas where this species should be favored in forest management, or where it could be planted with reasonable chances of success.

Yellow poplar has been found to grow best on deep, moist but well drained soils, and poorly or not at all on dry, exposed sites and on heavy, wet soils. It also happens that the same conditions which favor good yellow poplar growth are largely responsible for maximum organic matter accumulation and incorporation in the surface soil under normal, undisturbed conditions.

There is great variation in the depth to which organic debris becomes incorporated normally into the surface soil. Within the range of yellow poplar in the Brown Forest Soil Province of the Central States this depth may vary from no incorporation, with visible evidence of soil leaching, to twelve inches or more. The reasons for this variation become more or less obvious if we consider conditions under two extremes of site - moist, sheltered coves or bottoms in contrast with dry, exposed ridges.

Sites most favorable to vegetative growth produce the most luxuriant foliage and hence the most litter. In his soil study of the Mont Alto State Forest (Penna. Research Bull. 4) the writer found that the annual leaf-fall on cove, slope, and ridge sites averaged 5500, 3600, and 3000 pounds per acre, respectively. Furthermore, litter blown about the forest floor has a tendency to shift from dry, exposed slopes and ridges and accumulate in sheltered, moist sites. With this greater accumulation comes more complete incorporation by soil fauna because moist sites are more favorable for their existence and activities. Although litter decomposition is more rapid in moist than in dry soil, the type of decomposition with moisture favors humification and preservation of the carbonaceous portion in contrast to its loss through slow oxidation on exposed ridges and on hot south slopes, where litter destruction by fire is also most frequent. Retention of organic matter is favored in finer-textured soils, and cove or bottomland soils are generally finer in texture than ridge and slope soils because differential erosion

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from varying surface run-off velocities tends to segregate particle sizes, and deposit the finer textured particles on the lower and more level areas.

It follows that those factors which favor organic matter incorporation likewise favor occurrence and growth of certain tree species, including yellow poplar. The fact that yellow poplar is found commonly in coves and on north slopes where the deepest organic or A_1 soil horizons are developed indicates a direct relationship. Indeed this relationship of A_1 soil horizon depth to tree occurrence and growth exhibits its extreme manifestation not only in differences in growth rate but even in changes in forest species composition. The basic assumption, then, is that depth of organic matter incorporation representing its production, decomposition, and incorporation is an index or integration of all the meteorologic, biotic, and pedologic factors of site which influence tree occurrence and rate of growth.

In this study of yellow poplar site requirements, preliminary analysis of the data for 78 plots showed a substantially linear relationship between mean annual height growth and depth of the A_1 horizon. The range of A_1 horizon depths was from 1 to 12 inches and the height-age ratio of trees was from .64 foot to 4.0 feet. The evidence was rather convincing that yellow poplar will not grow successfully on sites whose original or potential A_1 horizon is less than 1 inch deep; that the rate of tree growth increases directly with the A_1 potentialities of the site; but that any A_1 depth over 10 inches is either ineffective or indicative of swamp or prairie conditions to which yellow poplar is not indigenous.

As the result of a further refinement of the statistical analysis by the Bruce and Reineke method (USDA Tech. Bull. 210) the accompanying alinement chart is offered as a means of evaluating yellow poplar sites. If the major premise holds as true under all field conditions as the statistical analysis indicates, then this method should be applicable universally in the region and may be developed for species other than yellow poplar. This method of site appraisal should be found useful in the management of existing stands where questions arise as to choice of species which should be favored, as well as in selecting sites for planting yellow poplar.

The correlation of tree growth with depth of organic matter penetration naturally stimulates conjecture whether growth of yellow poplar is accelerated by the soil organic matter or whether the organic matter is merely incidental as a result of site conditions favorable to its accumulation as well as to tree growth. If yellow poplar would not reseed, become established, and thrive on any soil but that with a plentiful supply of organic matter, it might be concluded logically that growth of the species depended on it. However, yellow poplar often reproduces and grows rapidly on old fields whose surface organic matter has been

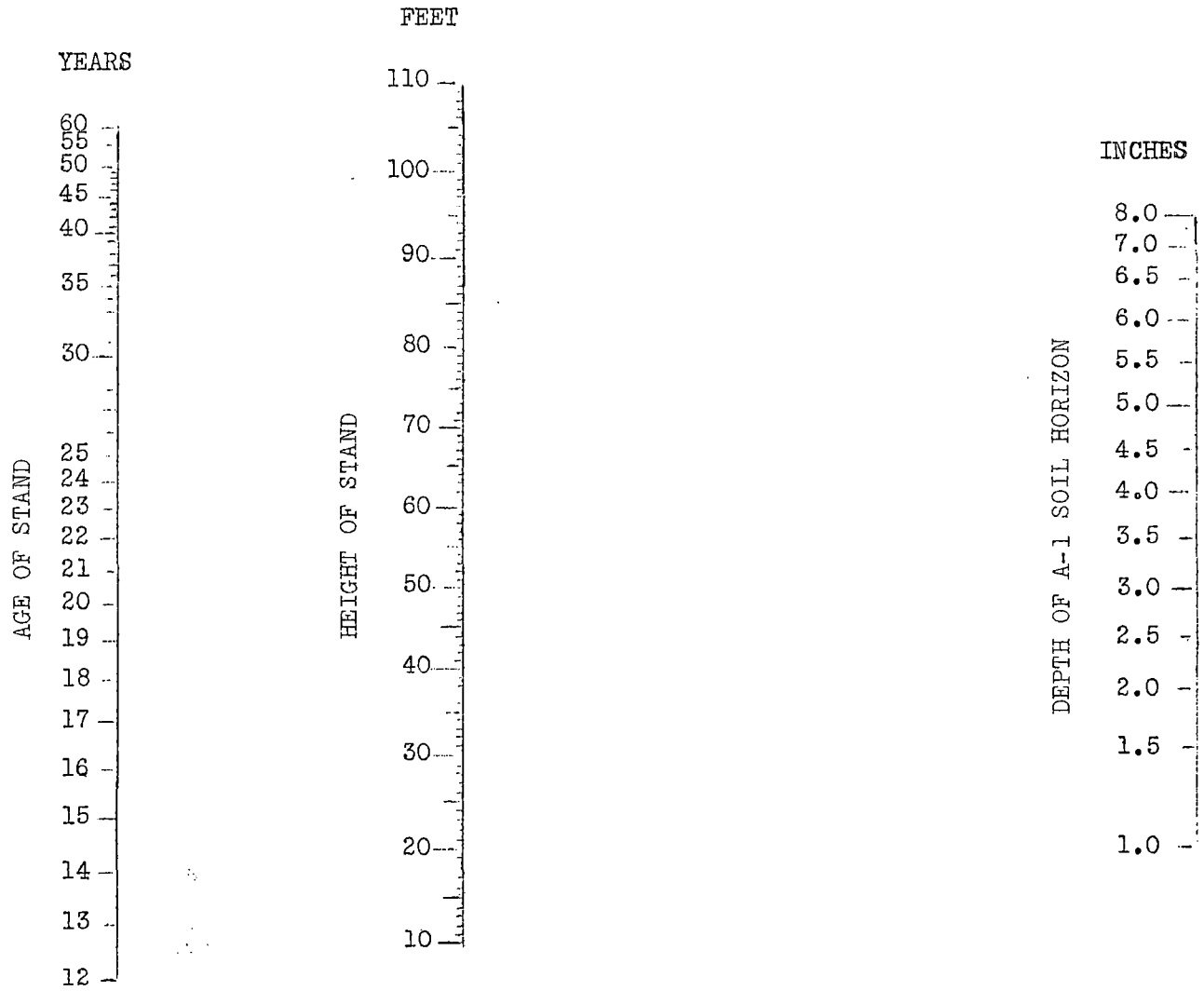
removed by erosion and oxidation. Once established on such areas, in a comparatively short time it produces enough litter to enrich the upper soil with organic matter in an amount commensurate with the initial productivity of the site. Numerous yellow poplar stands have been observed which, in the memory of the owners, have reseeded and developed well on abandoned fields. The organic matter penetration in these areas has been so rapid and to such a depth that the plow depth is now determined with difficulty. There is no doubt that the deposited organic matter influences growth rate in a cumulative manner as it grows in amount, but its presence is largely a result and not a cause.

Since many of the areas with which foresters must deal are no longer in normal condition, and the original organic matter layer may have been disturbed or obliterated by clearing and cultivation or by destruction of good forest conditions by excessive cutting, grazing, or fire, it becomes necessary to keep in mind that this method of evaluation is based upon the potentialities of the site as indicated by the original penetration of organic matter. Often the original A_1 horizon depth may be approximated along a fence row or in a clump of woods adjacent, where the soil has remained undisturbed. If neither of these alternatives is available, then measurements may be taken on the nearest site where conditions are similar to those under consideration. Due regard should be given to similarity of aspect, exposure, altitude, and soil profile with the area under consideration.

Situations may be encountered where extreme erosion may seem to render prediction difficult, but it must be remembered under these circumstances that yellow poplar never thrived over tight, poorly drained subsoils or on excessively dry sites even in the virgin forest, nor was a deep A_1 horizon developed under such conditions. Yellow poplar occurred in virgin stands on deep, moist, well-drained soils. Whatever change erosion brings about on a deep, immature soil profile is for the most part only a temporary surface phenomenon, but it may make tree establishment somewhat more difficult. Numerous yellow poplar stands have been found mixed with sassafras whose ages indicated that the latter species first occupied the site; then yellow poplar seeded in and became dominant. In reforesting particularly difficult areas, it may be necessary to start with some species adapted to establishment under difficult surface soil conditions even though the area may be a potential yellow poplar site. Yellow poplar may follow later when surface soil conditions suitable for its establishment have been restored.

Statistical Analysis of Data

Departing from mean annual height growth, age, and depth of the A_1 horizon, the three variables used in the preliminary analysis, height in feet, age in years, and depth of the A_1 soil horizon in inches were substituted. The multiple correlation coefficient of the three variables; height of stand in feet, age of stand in years, and depth of the A_1 soil horizon in inches from 78 plots, assuming straight line regression, was .70. The regression equation was: (Height of stand in feet) = 1.125 (Age of stand in years) + 2.62 (Depth of A_1 soil horizon in inches) + 23.06 feet. The Standard Error of Estimate was 12.12 feet. On the basis of the first estimate from which this equation was derived, the partial regression coefficient of A_1 soil horizon depth, 2.62, by Fisher's "t" test was highly significant. This coefficient signifies that for each inch of increment in A_1 soil horizon depth there was an increase of 2.62 feet in height of the average-aged stand. Since plotting of the data disclosed curvilinearity for both height-age and height-A_1 soil horizon depth relationships, the Bruce and Reineke method of graphical correction was used. This resulted in a correlation index of .78 with a standard error of estimate of $\pm$ 10.6 feet. The final estimate by this method gave an alienation index of .63 which squared and subtracted from unity indicated that approximately 60 per cent of variation in height was explained by age and depth of A_1 soil horizon.



ALINEMENT CHART SHOWING HEIGHTS OF
YELLOW POPLAR
ON SITES HAVING VARYING A-1 SOIL HORIZON DEPTHS
BASED ON NORMAL ORGANIC MATTER
INCORPORATION